SUPPORT FOR THE AMENDMENTS

Claims 6 and 14 are amended to use the wording consistent with these claims as in the Listing of Claims filed July 17, 2006. In the Listing of Claims filed July 12, 2007, the wording of these claims was unintentionally changed from "Pt" to "electrically conductive." The present amendment corrects that error and returns the claim description to the original wording.

No new matter will be added to this application by entry of this amendment.

Claims 6, 7 and 12-15 are active.

REMARKS/ARGUMENTS

The claimed invention is directed to an ultrasonic sensor having a structure:

Metal/Ferroelectric/Metal/Insulator/Semiconductor (MFMIS)

wherein a lower electrode and an integrated circuit are integrated. The claimed invention addresses this problem by providing an ultrasonic sensor comprising: a γ-Al_2O_3 single crystal film epitaxially grown on a semiconductor single crystal substrate; an epitaxial single crystal Pt thin film disposed on the γ-Al_2O_3 single crystal film; a highly oriented ferroelectric thin film disposed on the epitaxial single crystal Pt thin film; and an upper electrode disposed on the ferroelectric thin film; wherein the semiconductor single crystal substrate is subjected to a treatment for adjusting a resonant frequency and an ultrasonic wave to be detected. No such ultrasonic sensor is disclosed or suggested in the cited references.

The rejection of Claims 6, 12 and 14 under 35 U.S.C. 103(a) over Pohjonen et al. (U.S. 6,242,843) in view of Higuchi et al. (U.S. 2005/0179342) and further in view of Sakashita et al. (U.S. 2005/0040516) is respectfully traversed.

The combination of the cited references does not disclose or suggest the ultrasonic sensor as described in Claim 6 of the claimed invention.

Pohjonen is directed to resonator structures for radio communication apparatus which contains three basic elements: a) an acoustically active piezoelectric layer, b) electrodes on opposite sides of the piezoelectric layer, and c) acoustical isolation from the substrate. This structure is constructed to resonate at specific frequencies based on input to the piezoelectric layer from the electrodes. The Office has cited Fig. 7 of this reference as illustrating an ultrasonic sensor. However, this is not correct, because as indicated above, the structure shown in Fig. 7 is a resonator which is different from an ultrasonic sensor. Applicants respectfully submit that an ultrasonic sensor detects an external ultrasonic wave on the ferroelectric thin film and creates input to another device commensurate with the intensity of the detected wave or the frequency of the wave.

The Office has alleged that Fig. 7 discloses a structure similar to that of the ultrasonic sensor described in Claim 6. However, Applicants respectfully submit that the similarity is superficial and that the reference does not disclose or suggest the ultrasonic sensor of the claimed invention as described in Claim 6. In Pohjonen's Fig. 7, the bottom electrode (110) is isolated from the substrate (200) by a membrane layer (130). The reference neither discloses nor suggests a crystalline structural relationship interrelating the substrate, membrane layer, bottom electrode and the piezoelectric layer.

In contrast, the claimed invention clearly describes a crystal structure relationship between the semiconductor single crystal substrate, the γ-Al_2O_3 single crystal film, the single crystal Pt thin film and the ferroelectric thin film. The described relationship is that the γ-Al_2O_3 single crystal film is **epitaxially grown** on the semiconductor single crystal and the

single crystal Pt thin film is epitaxial to the γ-Al_2O_3 single crystal film. Applicants have described in the specification that a highly oriented ferroelectric film is obtained when the lower electrode are of single crystal structure with the (001) faces aligned (page 2, lines 20-25).

Applicants have described the single crystal orientation of the respective semiconductor, γ-Al_2O_3 single crystal and Pt thin films on pages 8-13 of the specification and in Figs. 4-8. Applicants note the Examiner's reference to "product by process" limitation. However, Applicants respectfully submit that the phrases "epitaxially grown" and "epitaxial single crystal . . . disposed on" are descriptive of a crystal relationship between the respective single crystal thin films and not process determining. As indicated in the attached description of "Epitaxy" from encyclopedia.the freedictionary.com epitaxial growth can be accomplished by vapor-phase, liquid-phase or molecular-beam methods and that **epitaxial films are films wherein a deposited film takes on a lattice structure and orientation identical to those of the substrate.** It is this single crystal orientation relationship between the respective thin films which is described in Claim 6 and not the process for preparation.

The Office has admitted that Pohjonen does not disclose the use of a single crystal material for the electrically conductive thin film or the use of a highly oriented ferroelectric film. Applicants respectfully add that this reference also does not disclose or suggest a single crystal membrane layer having an epitaxial relationship with the substrate and the bottom electrode and thereby the single crystal relationship between the substrate and the bottom electrode described in the claimed invention cannot be present.

The Office has cited Higuchi to show that a single crystal platinum film as an electrode and a well oriented piezoelectric film are well known in the art. Higuchi is directed

to a piezoelectric actuator for an ink jet recording device. The Office has cited [0002] and [0003] in support of its position. However, Applicants respectfully submit that careful reading of [0003] indicates that Higuchi describes problems that are associated with the use of a Pt electrode and therefore according to this reference, strontium ruthenate is employed as a bottom electrode. Applicants therefore respectfully submit that Higuchi, effectively teaches away from a Pt bottom electrode. Moreover, the technology to which this reference is directed is unrelated to the technology of an ultrasonic detector and there is no motivation to one skilled in the art of ultrasonic sensors to employ single crystal Pt bottom electrode provided by this reference.

Applicants also respectively point out that Higuchi does not disclose or suggest a γ-Al_2O_3 single crystal thin film between the bottom electrode and a substrate having an epitaxial relationship with the substrate and the bottom electrode and thereby the single crystal relationship between the substrate and the bottom electrode described in the claimed invention. Therefore, Applicants respectfully submit that Higuchi cannot cure the basic deficiencies of Pohjonen as described above.

Sakashita is cited to show epitaxially grown γ-Al_2O_3 film as a buffer layer between a lower electrode and a support substrate. Sakashita is directed to a thin film capacitor including a first electrode structural body, a second electrode structural body, and a dielectric thin film containing a bismuth layer structured compound between them. As shown in Fig. 4 and described in [0047] a buffer layer 32 is located between a support substrate 30 and lower electrode thin film 34. The reference states:

> "The material for forming the buffer layer 32 is not particularly limited insofar as the surface 32a of the buffer layer 32 can be influenced by the orientation of the surface 30a, of the support substrate 30 so as to be oriented in the [001] direction. For example, the buffer layer 32 can be

> formed of ZrO_2, or ReO_2, ReO_2- ZrO_2, where Re is yttrium (Y) or a rare earth element, MgO, $MgAl_2O_4$, γ-Al_2O_3, $SrTiO_3$, $LaAlO_3$ or the like."

Applicants have described significant improvement in epitaxial orientation between a Pt single crystal and a buffer layer when the buffer layer is single crystal γ-Al_2O_3 on page 9 in the specification and in Figs. 5 and 6. Sakashita does not disclose or suggest such improvement.

Moreover, as indicated in the journal articles provided in the Information Disclosure Statement accompanying this paper, Applicants are the first to actually successfully grow and describe an epitaxial Pt (001) thin film on a Si (001) substrate using an epitaxial γ-Al_2O_3 (001) buffer layer (Journal of Crystal Growth, 264 (2004) 463-467).

Therefore, Applicants respectfully submit that Sakashita does not disclose an ultrasonic sensor having the improved epitaxial single crystal orientation according to the claimed invention and cannot cure the deficiencies of the combination of Pohjonen and Higuchi as described above.

Applicants respectfully call the Examiner's attention to the following excerpt from the Office's own discussion of **"Examination Guidelines for Determining Obviousness Under 35 U.S.C. 103 in View of the Supreme Court Decision in *KSR International Co. v. Teleflex Inc.*"**

> "The rationale to support a conclusion that the claim would have been obvious is that all the claimed elements were known in the prior art and one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art at the time of the invention.[43] ""[I]t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does."[44] **If any of these findings cannot be made, then this rationale cannot be used to support a conclusion that the**

> **claim would have been obvious to one of ordinary skill in the art,"** (Federal Register, Vol. 72, No. 195, page 57529) **(Bold added)**

Applicants respectfully submit that in view of the foregoing, one skilled in the art would not have been motivated to combine the descriptions of the cited references to arrive at the ultrasonic sensor of the claimed invention wherein there would be no change in the functions of the respective elements, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art at the time of the invention. Therefore Applicants respectfully submit that a conclusion of obviousness cannot be supported and withdrawal of the rejection of Claims 6, 12 and 14 under 35 U.S.C. 103(a) over Pohjonen et al. in view of Higuchi et al. and further in view of Sakashita et al. is respectfully requested.

The rejection of Claims 7, 13 and 15 under 35 U.S.C. 103(a) over Pohjonen et al. in view of Higuchi et al. and further in view of Sakashita et al. and further in view of Ziegler (U.S. 6,238,946), Ando et al. (2004/0021401) and Tabata et al. (U.S. 5,354,732) is respectfully traversed.

Claims 7, 13 and 15 all depend directly or indirectly from Claim 6. None of the cited references cure the basic deficiencies of the primary references as described above and therefore cannot render these claims obvious.

Ziegler is cited to show use of silicon on insulator (SOI) substrate. Ando is cited to show etching of Si single crystal (100) face and Tabata is cited to show gold black as an electrode material. However, Applicants respectfully submit that none of the cited secondary references disclose or suggest an ultrasonic sensor comprising: a γ-Al_2O_3 single crystal film epitaxially grown on a semiconductor single crystal substrate; an epitaxial single crystal Pt

thin film disposed on the γ-Al_2O_3 single crystal film; a highly oriented ferroelectric thin film disposed on the epitaxial single crystal Pt thin film; and an upper electrode disposed on the ferroelectric thin film; wherein the semiconductor single crystal substrate is subjected to a treatment for adjusting a resonant frequency and an ultrasonic wave to be detected. Therefore, none of the cited references cures the deficiency of the primary references. Withdrawal of the rejection of Claims 7, 13 and 15 under 35 U.S.C. 103(a) over Pohjonen et al. in view of Higuchi et al. and further in view of Sakashita et al. and further in view of Ziegler (U.S. 6,238,946), Ando et al. (2004/0021401) and Tabata et al. (U.S. 5,354,732) is respectfully requested.

Applicants respectfully submit that the above-identified application is now in condition for allowance and early notice of such action is earnestly solicited.

Respectfully submitted,

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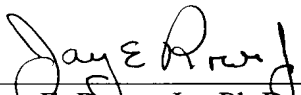

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